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| "Express Mail" mailing label number <u>ET383429629US</u>  |                         |
| Date of Deposit <u>February 13, 2002</u>  |                         |
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| <u>Erich D. Hemm</u><br>Attorney mailing application  | <u>47,286</u><br>Reg No |
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Case 8417M

## FLAVORED COFFEE COMPOSITIONS AND METHOD OF MAKING

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### CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 60/268,443, filed February 13, 2001.

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### FIELD OF THE INVENTION

The present invention relates to novel coffee compositions with enhanced flavor characteristics. In particular, the present invention relates to novel processes for preparing enhanced coffee compositions and the products comprising them.

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### BACKGROUND OF THE INVENTION

High quality coffee food and beverage products enjoy considerable popularity and make up an increasingly significant proportion of the diets of many people. However, these high quality coffee products are both expensive to purchase and to produce. One such reason is the cost of the raw materials. Due to the nature of coffee production (e.g., growing cycle, season, location, and the like) it is difficult to offset an increase in demand for consumer preferred coffees with additional levels of supply. This results in higher production costs for high quality coffee food and beverage products that must eventually be borne by the consumer.

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One such approach to reducing coffee product costs has been the use of low cost coffee products, and the subsequent adjustment of acidity in an attempt to approximate the overall acidity level of the consumer preferred coffee product.

Yet another approach to reducing cost has been the use of blends of high cost and low cost coffee varieties. Expensive coffees having consumer preferred taste characteristics are blended with less expensive, less taste preferred coffee varieties.

However, this solution is not without its own set of problems. Most notably, the inverse

5 relationship that exists between the use of less preferred coffee varieties and a consumer's positive taste perception of the finished coffee product. As the proportion of "cheaper" coffees used increases, a consumer's positive flavor perception of the finished coffee product decreases. Moreover, coffee products made from blends of high cost and low cost coffees frequently impose additional processing and production complexities. This, in

10 turn, can also increase production and consumer purchase cost.

Examples of these approaches can be found in European Patent Application No. 0 282 762 to Varsanyl et al.; EP 0 861 596A1 to Bradbury et al.. Additional examples can be found in U.S. Patent No. 5,993,877 to Ohtake et al.; U.S. Patent No. 5,853,787 to Tamer et al.; U.S. Patent No. 5,229,155 to Weisemann et al.; and U.S. Patent No.

15 2,853,387 to Nutting.

Considerable effort, therefore, has been expended in an attempt to address the consumer acceptance limitations of using low cost coffees in the production of high quality coffee products. Yet there remains a need in the art for compositions and methods for flavoring coffee that ensure consistent, high product quality, and that are both easily adaptable to a

20 variety of less costly coffee materials and economical and easy to use. Accordingly, it is an object of the present invention to provide compositions and methods which address these needs and provide further related advantages.

## BRIEF DESCRIPTION OF THE DRAWINGS

25 The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

Fig. 1 Is a representation of the Coffee Source Component Profile of a Coffee Source.

30 Fig. 2 Is a representation of a Target Coffee Component.

Fig. 3 Is a representation of a Target Coffee Component.

Fig. 4 Is a flow diagram describing the process steps of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

5 The present invention relates to novel coffee compositions with specific flavor characteristics. In particular, the present invention relates to novel processes for preparing flavored coffee compositions and the products comprising them.

### A. DEFINITIONS

10 As used herein, the term “coffee source” is defined as a beverage source derived from a plant of the Family *Rubiaceae*, Genus *Coffea*, from a given region of origin. One skilled in the art will appreciate that by region of origin it is meant a coffee growing region wherein the coffee growing process utilizes identical coffee seedlings. Additionally, a region of origin experiences similar soil conditions, fertilization

15 conditions, growing environment (e.g., rainfall amount, temperature, altitude, sunlight), and pre-roasting process, handling, and storage conditions.

20 There are many coffee species, however, it is generally recognized by those skilled in the art that there are two primary commercial coffee species, *Coffea arabica* and *Coffea canephora* var. *robusta*. Coffees from the Species *arabica* are described as “Brazils,” which come from Brazil, or “Other Milds” which are grown in other premium coffee producing countries. Premium arabica countries are generally recognized as including Colombia, Guatemala, Sumatra, Indonesia, Costa Rica, Mexico, United States (Hawaii), El Salvador, Peru, Kenya, Ethiopia and Jamaica. Coffees from the Species *canephora* var. *robusta* are typically used as a low cost extender for *arabica* coffees. 25 These robusta coffees are typically grown in the lower regions of West and Central Africa, India, South East Asia, Indonesia, and Brazil.

30 The coffee source can be in a variety of forms including, but not limited to, cherries, beans, leaves, and bark. Additionally, the coffee source can take the form of soluble coffee, roast and ground, roasted whole bean, green coffee, and extracts of coffee via aqueous, super-critical fluid, and organic solvent extraction processes. The coffee source can also be caffeinated, decaffeinated, or a blend of both.

As used herein, the term “coffee source component” is defined as one of the taste contributing acids contained within the coffee source. One skilled in the art will appreciate that by the term acid it is meant the combination of the acid’s associated and dissociated forms. The coffee source component is generated or formed as a result of 5 coffee source growing, harvesting, processing, roasting, fermentation, preparation, handling and/or storage processes.

As used herein, the term “taste contributing” is defined as an acid contained within the coffee source whose concentration is perceptible by taste at a concentration in water that is identical to the concentration of the acid in the target coffee and is directly or 10 inversely correlated to roasting conditions, or whose concentration varies with coffee region of origin, or whose concentration varies with coffee species. Perceptible by taste is defined as modifying the sensory perception of one or more of the following beverage flavor characteristics: sweet, sour, salty, bitter, soury, winey, acidy, mellow, bland, sharp, harsh, pungent, etc..

15 As used herein, the term “coffee source component profile” is defined as the concentration of coffee source components present within the coffee source. The coffee source component profile can be represented by a graph, a table, or some other suitable visual representation showing the existence and concentrations of coffee source components.

20 As used herein, the term “supplemental coffee source component” is defined as a taste contributing acid. The taste contributing acid of the supplemental coffee source component corresponds to the taste contributing acid of the coffee source component, though it may exist in the same or a different form of the acid. The supplemental coffee source component can exist in one or more forms selected from the following group: 25 acidic form of the taste contributing acid, anionic form of the taste contributing acid, and metallic and ammonium salt of the taste contributing acid.

As used herein, the term “coffee source component modifier” is defined as a 30 compound, or set of compounds, that adjusts the perceptible concentration of one or more coffee source components. Acceptable coffee source component modifiers include one or more of the following sodium, magnesium, potassium, hydrogen, calcium, and

ammonium cations, in combination with hydroxide, carbonate, bicarbonate, gluconate, and sulfates.

The addition of a coffee source component modifier will modify the taste perceptible concentration of one or more coffee source components. The addition of a coffee source component modifier is also used to adjust the pH value of the coffee portion of the coffee beverage or composition, to within an acceptable range of the pH value of the coffee portion of the target coffee composition or beverage.

As used herein the term “resulting coffee component” is defined as the combination of a coffee source component and a corresponding supplemental coffee source component.

As used herein the term “resulting coffee component profile” is defined as the concentration of one or more resulting coffee components present within a coffee portion. The resulting coffee component profile can be represented by a graph, a table, or some other suitable visual representation showing the existence and concentrations of resulting coffee components.

As used herein, the term “target coffee” is defined as a desired coffee beverage or coffee composition. The target coffee comprises a coffee element that is generally derived from a bean or a blend of beans from a plant of the Family *Rubiaceae*, Genus *Coffea*, from a given region of origin. However, the coffee element of the target coffee can also be derived from a variety of coffee materials including, but not limited to, cherries, beans, leaves, and bark. Additionally, the coffee element of the target coffee can take the form of soluble coffee, roast and ground, roasted whole bean, green coffee, and extracts of coffee via aqueous, super-critical fluid, and organic solvent extraction processes. The coffee element can also be caffeinated, decaffeinated, or a blend of both.

25 As used herein, the term "target coffee component" is defined as one of the taste contributing acids contained within the coffee element of the target coffee. One skilled in the art will appreciate that by the term acid it is meant the combination of an acid's associated and disassociated forms. The target coffee component is generated or formed as a result of target coffee growing, harvesting, processing, roasting, fermentation, 30 preparation, handling and/or storage processes.

As used herein, the term “target coffee component profile” is defined as the concentration of target coffee components present within the coffee element of the target coffee. The target coffee component profile can be represented by a graph, a table, or some other suitable visual representation showing the existence and concentrations of target coffee components.

## B. Coffee Source

It has been determined according to the present invention that coffee beverages and compositions that exhibit consumer preferred flavor characteristics may be produced from a variety of coffee sources. The preferred coffee source for a particular use may vary according to considerations of availability, expense, and flavor associated with the coffee source. Additionally, the degree and nature of impurities and other components in the coffee source may be considered. A coffee beverage composition may also be produced from a blend of one or more suitable coffee sources.

The coffee beverages and compositions of the present invention comprise a coffee portion, and may optionally contain additional components, such as foaming agents, mouthfeel enhancing agents, flavorants, creamy components, inert fillers and carriers, sweetening agents, and the like. The coffee portion is comprised of a coffee source, and any supplemental coffee source component and/or coffee source component modifier required.

Coffee sources exist in a variety of forms including, but not limited to, cherries, leaves, bark, soluble coffee, instant coffee, roast and ground, roasted whole bean, green coffee beans, extracts including aqueous, super-critical fluid, and organic solvents, and mixtures thereof. Furthermore, the coffee source can be caffeinated, decaffeinated, or a blend of both. It is recognized that coffee sources suitable for use in the present invention may contain various impurities and/or by-products.

Coffee sources of the present invention are defined by coffee variety (i.e., coffee species and region of origin). By region of origin it is meant a coffee growing region wherein the coffee growing process utilizes identical coffee seedlings. Additionally, a region of origin experiences similar soil conditions, fertilization conditions, growing environment (e.g., rainfall amount, temperature, altitude, sunlight), and pre-roasting

process, handling, and storage conditions. The species, region of origin, and coffee growing, harvesting, processing, roasting, fermentation, preparation, handling and/or storage process conditions determine the presence and concentration of a given acid in a coffee source.

5 It has been found that the coffee sources of the present invention contain one or more of the following acids: Formic, Acetic, Propanoic, Butanoic, Pentanoic, Hexanoic, Heptanoic, Octanoic, Nonanoic, Decanoic, Palmitic, Crotonic, Isocrotonic, Hydroxyacetic, Isobutyric, Lactic, 3-hydroxypropanoic, Glyceric, 2,3-dihydroxypropanoic, 2-(4-methoxyphenoxy) propanoic, 2-hydroxybutyric, 2,4-dihydroxybutyric, 2-methylbutanoic, Isovaleric, Methacrylic, Tiglic, Angelic, 3-methyl-2-butenoic, Pyruvic, 2-Oxobutyric, 3-oxobutanoic, Levulinic, Oxalic, Malonic, Succinic, Glutaric, Fumaric, Maleic, Methylsuccinic, Malic, Tartaric, 2-hydroxyglutaric, Ketoglutaric, Citraconic, Mesaconic, Itaconic, Citric, Aspartic, Glutamic, Pyroglutamic, Nicotinic, 2-Furoic, Benzoic, 3-hydroxybenzoic, 4-hydroxybenzoic, 2,5-dihydroxybenzoic, 3,4-dihydroxybenzoic, 3,4,5-Trihydroxybenzoic, 1,2,4-trihydroxybenzoic, Vanillic, Phytic, Phosphoric, Quinic, Caffeic, Ferulic, 3-(4-Hydroxy-3-methoxyphenyl)-2-propenoic, p-coumaric, o-coumaric, 4-methoxycinnamic, 3,4-dimethoxycinnamic, 3,4,5-trimethoxycinnamic, 3-caffeoylquinic, 4-caffeoylquinic, 5-caffeoylquinic, 3-feruloylquinic, 4-feruloylquinic, 5-feruloylquinic, 3,4-dicaffeoylquinic, 20 3,5-dicaffeoylquinic, 4,5-dicaffeoylquinic, p-coumaroylquinic, caffeoylferuoylquinic. The exact concentration within a given coffee source depends on the coffee species selected, the growing and harvesting conditions, and the coffee source preparation processes described above.

25 Coffee sources have been found to contain varying levels of acids depending on its form. For example, green coffee has been found to contain approximately 11% total acid by weight, Roasted coffee has been found to contain approximately 6% total acid content by weight, and instant coffee has been found to contain approximately 16% total acid content by weight.

### C. Coffee Source Component

A coffee source component is defined as a taste contributing acid present within a given coffee source. As used herein the term "taste contributing" is defined as an acid contained within the coffee source that is perceptible by taste at a concentration in water

5 that is identical to the concentration of the acid in the target coffee. Perceptible by taste is defined herein as modifying the sensory perception of one or more of the following flavor characteristics: sweet, sour, salty, bitter, soury, winey, acidy, mellow, bland, sharp, harsh, pungent, etc.. In addition, a taste contributing acid is an acid whose concentration exhibits at least one of the following phenomenon: a roast effect; a coffee species effect;

10 and a coffee region of origin effect.

As used herein the term roast effect is defined as the existence of a relationship between the concentration of the acid in a roasted coffee source and the roasting conditions selected. One skilled in the art will appreciate that roasting conditions are generally recognized as time, heat input and moisture. One skilled in the art will also

15 appreciate that the roasting conditions selected for a given coffee source can be characterized by roast time, roasting equipment, and a Hunter L\* color. As used herein, color differences are defined in terms of readings measured on a Hunter colorimeter and specifically the values L\*, a\* and b\* derived from the Hunter CIE scale. See pages 985-95 of R. S. Hunter, "Photoelectric Color Difference Meter," *J. of the Optical Soc. of Amer.*, Volume 48, (1958), herein incorporated by reference.

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As used herein, the term coffee species effect is defined as an acid having a concentration in a coffee source of one coffee species, subjected to a given set of growing, harvesting, and processing conditions, that is different from the concentration in a different coffee species, subjected to identical growing, harvesting, and processing

25 conditions. As used herein, the term coffee region of origin effect is defined as an acid having a concentration that is dependent on the coffee growing, harvesting, processing, roasting, fermentation, preparation, handling and/or storage processes.

The presence of a given coffee source component, and its corresponding concentration within a coffee source, is a function of many factors. The factors vary

30 depending on the specific coffee source selected. Most notable among these, however, is the selection of a specific coffee species. Additionally, growing conditions such as

rainfall amounts, temperature, fertilization, harvesting, handling, and storage of the coffee species contribute greatly to the presence and concentration of a given coffee source component. Moreover, subsequent processing and preparation of the coffee species may significantly impact coffee source component concentrations.

5 The coffee source component can exist within a coffee source in a variety of forms. Typically the coffee source component is present in the acidic form of the taste contributing acid. As an acid, the coffee source component exists in both the associated and disassociated forms of the acid. However, it has been found that in the present invention suitable coffee source components may also exist as a salt of the taste  
10 contributing acid.

#### **D. Coffee Source Component Profile**

A Coffee source component profile is defined as the concentration of coffee source components present within a given coffee source. The coffee source component  
15 profile represents the coffee source component concentration at a pH value of 14, in the completely dissociated form of the acid. The coffee source component profile can take the form of a graph, a table, or some other suitable visual representation showing the existence and concentrations of beverage source components.

Table 1 is a tabular representation of the coffee source component profile of a  
20 roast and ground coffee source (Vietnam robusta, roasted for 854 seconds on a Thermalo batch roaster, to a Hunter L-color of 17.68). Fig. 1 is a graphical representation of the same coffee source component profile.

**Table 1**  
**Vietnam robusta, roasted for 854 seconds on a Thermalo batch roaster to a Hunter L-color of 17.68**

| Coffee Source Component (Anionic Form) | Concentration (ppm) |
|--|---------------------|
| <b>Quinate</b>                         | <b>79</b>           |
| <b>Lactate</b>                         | <b>30</b>           |
| <b>Acetate</b>                         | <b>119</b>          |
| <b>Formate</b>                         | <b>45</b>           |
| <b>Malate</b>                          | <b>24</b>           |
| <b>Fumarate</b>                        | <b>27</b>           |
| <b>Phosphate</b>                       | <b>77</b>           |
| <b>Citrate</b>                         | <b>85</b>           |

## **E. Target Coffee, Target Coffee Component, and Target Coffee Component Profile**

As used herein the term “target coffee” is defined as a target coffee beverage or 5 composition. The target coffee comprises a coffee element. The target coffees of the present invention may optionally contain additional elements, such as foaming agents, mouthfeel enhancing agents, flavorants, creamy components, inert fillers and carriers, sweetening agents, and the like.

The coffee element of the target coffee is derived from a plant of the Family 10 *Rubiaceae*, Genus *Coffea*, from a given region of origin. The coffee element of the target coffee can be in a variety of forms including, but not limited to, cherries, beans, leaves, and bark. Additionally, the coffee element can take the form of soluble coffee, roast and ground, roasted whole bean, green coffee, and extracts of coffee via aqueous, super-critical fluid, and organic solvent extraction processes. The coffee element can also be 15 caffeinated, decaffeinated, or a blend of both.

It has been found that the coffee element of the target coffee contains one or more of the following acids: Formic, Acetic, Propanoic, Butanoic, Pentanoic, Hexanoic, Heptanoic, Octanoic, Nonanoic, Decanoic, Palmitic, Crotonic, Isocrotonic, Hydroxyacetic, Isobutyric, Lactic, 3-hydroxypropanoic, Glyceric, 2,3-dihydroxypropanoic, 2-(4-methoxyphenoxy) propanoic, 2-hydroxybutyric, 2,4-dihydroxybutyric, 2-methylbutanoic, Isovaleric, Methacrylic, Tiglic, Angelic, 3-methyl-2-butenoic, Pyruvic, 2-Oxobutyric, 3-oxobutanoic, Levulinic, Oxalic, Malonic, Succinic, Glutaric, Fumaric, Maleic, Methylsuccinic, Malic, Tartaric, 2-hydroxyglutaric, Ketoglutaric, Citraconic, Mesaconic, Itaconic, Citric, Aspartic, Glutamic, Pyroglutamic, 25 Nicotinic, 2-Furoic, Benzoic, 3-hydroxybenzoic, 4-hydroxybenzoic, 2,5-dihydroxybenzoic, 3,4-dihydroxybenzoic, 3,4,5-Trihydroxybenzoic, 1,2,4-trihydroxybenzoic, Vanillic, Phytic, Phosphoric, Quinic, Caffeic, Ferulic, 3-(4-Hydroxy-3-methoxyphenyl)-2-propenoic, p-coumaric, o-coumaric, 4-methoxycinnamic, 3,4-dimethoxycinnamic, 3,4,5-trimethoxycinnamic, 3-caffeoylquinic, 4-caffeoylquinic, 5-caffeoylquinic, 3-feruloylquinic, 4-feruloylquinic, 5-feruloylquinic, 3,4-dicaffeoylquinic, 30 3,5-dicaffeoylquinic, 4,5-dicaffeoylquinic, p-coumaroylquinic, caffeoylferuoylquinic. The

exact concentration of an given acid within a the coffee element of the target coffee depends on the coffee species selected, the growing and harvesting conditions, and coffee element preparation processes described above.

5 The target coffee component profile is defined as the concentration of target coffee components present within the coffee element of the target coffee. The target coffee component profile can be represented by a graph, a table, or some other suitable visual representation showing the existence and concentrations of target coffee components.

10 In one embodiment of the present invention the coffee element is a Colombian arabica, roasted for 201 seconds on a Thermal batch roaster, to a Hunter L-color of 12.1. Figure 2 is a graphical representation of the Columbian Arabica's target component profile. In another embodiment of the present invention the coffee element is a Kenya AA (arabica), roasted on a Jabez Burns laboratory roaster for 10 minutes, to a Hunter L-color of 18.76. The target component profile is shown in Figure 3.

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#### **F. Coffee Source Component Modifier**

20 A coffee source component modifier is defined as a compound, or combination of compounds, that adjusts the perceptible concentration of one or more coffee source components. In solution, an acid can exist entirely in an associated form, entirely in a dissociated form, or as a combination of the two. The proportion of a given acid that exists in its associated and dissociated states is, in part, a function of the equilibrium constant for the given acid. It is the associated form of an acid that is responsible for taste. The human sense of taste detects the associated form of an acid, the dissociated form of the acid is imperceptible. In addition to adjusting the perceptible concentration of a 25 coffee source component, the coffee source component modifier adjusts the pH value of the coffee portion. Acceptable coffee source component modifiers include: sodium, magnesium, potassium, hydrogen, calcium, and ammonium cations, in combination with hydroxide, carbonate, bicarbonate, gluconate, and sulfates.

30 The coffee source component modifier compounds can exist in a variety of forms. The coffee source component modifier may exist in a solution of water, or some other suitable aqueous medium. Moreover, the coffee source component modifier can exist in

non-aqueous solutions (e.g., oil and glycerin). Alternatively, coffee source component modifier may exist as one or more dry ingredients.

The coffee source component modifier can be combined with the coffee source in a variety of ways, depending on the nature and form of the coffee source and the coffee source component modifier. If the coffee source selected were a roast and ground coffee, the coffee source component modifier could exist in an aqueous solution that is sprayed onto, or mixed with, the roast and ground coffee. Alternatively, the coffee source component modifier could exist in a dry state, and be mixed with the roast and ground coffee source in a coffee composition. When the coffee composition is transformed into a coffee beverage, the coffee source component modifier would then act to adjust the perceptible concentration of the coffee source component in the method described.

A coffee source component modifier existing in solution could also be applied (e.g., by spraying or mixing) to a roasted whole bean, green coffee bean, liquid coffee extract, soluble coffee, or other form of a coffee source (e.g., cherries, leaves, and the like). The same is true for a coffee source component modifier existing in a dry state. The coffee source component modifier can exist in any suitable form in an intermediate state of the final, consumable coffee beverage. The form of the coffee source component modifier is only limited by the need to exist in a state capable of adjusting the perceived concentration of the coffee source component, in the final, consumable form of the coffee beverage.

Coffee source component modifiers that are a combination of two or more suitable compounds can be combined with the coffee source together or separately. Additionally, multi-compound component modifiers can exist in different states (e.g., in solution or a dry state) so long as they are capable of adjusting the perceived concentration of the coffee source component, in the final, consumable form of the coffee beverage.

The coffee source component modifiers of the present invention also need not be applied directly to the coffee source to be effective. The coffee beverages and coffee compositions of the present invention may include additional ingredients, such as foaming agents, mouthfeel enhancing agents, flavorants, creamy components, inert fillers and carriers, sweetening agents, and the like. The coffee source component modifiers may be combined with any of these additional ingredients, in a suitable form, such that they

are capable of adjusting the perceived concentration of the coffee source component, in the final, consumable form of the coffee beverage.

#### **G. Supplemental Coffee Source Component**

5 A supplemental coffee source component is defined as a taste contributing acid. The taste contributing acid of the supplemental coffee source component corresponds to the taste contributing acid of the coffee source component, though it may exist in the same or a different form of the acid. The supplemental coffee source component can exist as either the acidic form of the taste contributing acid (e.g., Citric Acid; Malic Acid; 10 Formic Acid; Fumaric Acid; Phosphoric Acid; 2-Furoic Acid; Lactic Acid; Acetic Acid.), or as a salt of the taste contributing acid (e.g., Mono-, Di-, or Tri- Sodium Citrate; Mono-, Di-, or Tri- Potassium Citrate; Mono-, or Di- Sodium Malate; Mono- or Di- Potassium Malate; Sodium Formate; Potassium Formate; Mono- or Di- Sodium Fumarate; Mono- or Di- Potassium Fumarate; Mono- or Di- Sodium Phosphate; Mono- or Di- Potassium 15 Phosphate; Sodium Furoate; Potassium Furoate; Sodium Lactate; Potassium Lactate).

Though the supplemental source component can be any of the taste contributing acids, preferred taste contributing acids are the acids of the following anions: Quinate, Lactate, Acetate, Formate, 2-Furoate, 3-Methyl Malate, Citramalate, Hydroxyglutarate, Glutarate, Malate, Citraconate, Maleate, Mesaconate, Oxalate, Fumarate, Phosphate and 20 Citrate.

The supplemental coffee source components of the present invention can exist in a variety of forms. The supplemental coffee source component may exist in a solution of water, or some other suitable aqueous medium. Moreover, the coffee source component modifier can exist in non-aqueous solutions (e.g., oil and glycerin). Alternatively, 25 supplemental coffee source component may exist as one or more dry ingredients.

The supplemental coffee source component can be combined with the coffee source in a variety of ways, depending on the nature and form of the coffee source and the supplemental coffee source component. If the coffee source selected were a roast and ground coffee, the supplemental coffee source component could exist in an aqueous 30 solution that is sprayed onto, or mixed with, the roast and ground coffee. Alternatively, the supplemental coffee source component could exist in a dry state, and be mixed with

the roast and ground coffee source in a coffee composition. When the coffee composition is transformed into a coffee beverage, the supplemental coffee source component would then act to supplement the total concentration of the corresponding coffee source component in the method described.

5 A supplemental coffee source component existing in solution could also be applied (e.g., by spraying or mixing) to a roasted whole bean, green coffee bean, liquid coffee extract, soluble coffee, or other form of a coffee source (e.g., cherries, leaves, and the like). The same is true for a supplemental coffee source component existing as a dry ingredient. The supplemental coffee source component can exist in any suitable form, in  
10 an intermediate state of the final, consumable coffee beverage. The exact form of the supplemental coffee source component is only limited by the need to exist in a state capable of supplementing the total concentration of the corresponding coffee source component, in the final, consumable form of the coffee beverage.

15 Supplemental coffee source components that are a combination of two or more suitable compounds can be combined with the coffee source together or separately. Additionally, multi-compound supplemental coffee source components can exist in different states (e.g., in solution or a dry state) so long as they are capable of supplementing the total concentration of the corresponding coffee source component, in the final, consumable form of the coffee beverage.

20 The supplemental coffee source components of the present invention also need not be combined with the coffee source directly to be effective. The coffee beverages and coffee compositions of the present invention may include additional ingredients, such as foaming agents, mouthfeel enhancing agents, flavorants, creamy components, inert fillers and carriers, sweetening agents, and the like. The supplemental coffee source components  
25 may be combined with any of these additional ingredients, in a suitable form, such that they are capable of supplementing the total concentration of the corresponding coffee source component, in the final, consumable form of the coffee beverage.

## **H. Resulting Coffee Source, Resulting Coffee Component, Resulting Coffee Component Profile**

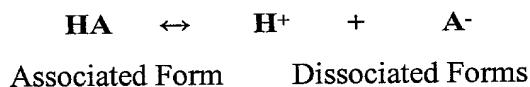
As used herein the term “resulting coffee component” is defined as the combination of a coffee source component and a corresponding supplemental coffee source component. As used herein the term “resulting coffee component profile” is defined as the concentration of one or more resulting coffee components present within a coffee portion. The resulting coffee component profile can be represented by a graph, a table, or some other suitable visual representation showing the existence and concentrations of resulting coffee components.

10

## **I. Perceptibility of Acids**

The Applicants have observed that the individual acids found in coffee each have an associated flavor note. It has also been observed by Applicants that specific combinations of these acids exhibit characteristic flavors based on the specific combination of acids and their associated flavor notes. Though the ability to perceive the associated flavor note for a given acid in solution by the sensory perception of taste is a function of its concentration, it is not necessarily directly correlated to the acid’s total concentration. Not intended to be limited by theory, Applicants believe that the sensory perception of taste is only capable of perceiving an acid in its associated form. Therefore, the portion of the total acid concentration in a dissociated state does not directly contribute to the taste perception of an acid’s associated flavor note, nor the perception of characteristic flavors based on the combination of associated flavor notes.

It is understood by the ordinarily skilled artisan that acids exist in both an associated and dissociated state when present in aqueous solutions. The molecular equilibrium is expressed simply as:



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The anions may also be found in solutions containing salts of the acid. For a more detailed discussion of the mathematical relationships for this equilibrium see *Quantitative Chemical Analysis*, 4<sup>th</sup> Edition, by Daniel C. Harris, W. H. Freeman and Company, 1995, pp. 217-270, herein incorporated by reference. The dissociation constant  $K_a$  for a given acid expresses the relationship of the three components of the equilibrium in terms of their molar concentrations:

$$K_a = ([H^+] [anions]) / [HA]$$

10 The hydrogen ion concentration is expresses by the symbol pH. The Henderson-Hasselbach equation relates the pH of a solution to the acid's  $K_a$  value:

$$pH = \log ([anions] / [HA]) - \log K_a$$

15 The negative logarithm of the dissociation constant is known as the  $pK_a$  value in a similar manner to the pH value, which is the negative logarithm of the hydrogen ion:

$$pH - pK_a = \log ([anions] / [HA])$$

20 Changes in the pH of a solution result in different concentrations of a given acid's associated and dissociated forms, depending on that given acid's  $pK_a$  value. Therefore, as the pH value of a solution changes so does the ability to perceive the taste of an acid's characteristic flavor note, or the characteristic flavor of a combination of specific flavor notes.

25

#### **J. Profile Matching and Manipulation**

Each acid in coffee has an associated flavor note. Specific combinations of coffee acids will exhibit a characteristic flavor profile based on the combination of associated flavor notes and the perceptible concentration of each of the acids in that combination.

30 Therefore, flavor profiles can be identified for specific coffees of interest wherein the flavor profile for that coffee is a function of the concentration of at a least a portion of the

acids in that coffee. Mathematically, the characteristic flavor profile for a specific combination of acids is expressed as the relative ratio of the concentrations of those acids to each other within that combination.

5 [A<sub>1</sub>]: [A<sub>2</sub>] : ... : [A<sub>n</sub>], where [A<sub>(1-n)</sub>] is the total concentration of the first acid to the n<sup>th</sup> acid, respectively.

10 At a given pH, and depending on the pKa of the specific acid, a portion of the concentration of a specific acid will be in a form perceptible by taste (i.e., the associated form of the acid). And therefore, it has been found that what imparts the perceived characteristic flavor of a given profile is the combination of perceptible concentrations of the acids within that combination and their relative ratios to each other.

15 [HA<sub>1</sub>]: [HA<sub>2</sub>] : ... : [HA<sub>n</sub>], where [HA<sub>(1-n)</sub>] is the perceptible concentration of the first acid to the n<sup>th</sup> acid, respectively.

20 Applicants have discovered that the flavor profile of a given coffee (e.g., a coffee source) may be readily adjusted so as mimic the characteristic flavor profile of a different coffee (e.g., a target coffee). As used herein, the term "mimic" is defined as approximating, imitating, or resembling in such a way as to deliver a substantially similar characteristic flavor.

25 As used herein, the term "corresponding acid" is defined as the acid of the same species. However, it will be appreciated by the ordinarily skilled artisan upon reading the disclosure herein that the corresponding acid does not necessarily have to exist in the same form as the acid of interest. The corresponding acid can exist in the associated form of the acid, the disassociated form of the acid, as a salt of the acid, or as combinations thereof. By way of example, if the acid of interest in a first coffee were malic acid then the corresponding acid in the second coffee would also be malic acid, though it may exist in a different form of the acid as described.

30 It will also be appreciated by those skilled in the art upon reviewing the disclosure herein, that although the majority of the acids commonly found in coffee have an

associated flavor note, not all of these acids will necessarily make a significant and/or preferred contribution to the characteristic flavor profile of a given coffee. Applicants have found that of the acids typically present in coffee only a select set of those can be considered relevant acids.

5 As used herein, the term “relevant acid” is defined as an acid that would be perceptible by taste at a concentration in water that is equal to the concentration of the acid in the target coffee and, has a concentration that varies according to the coffee roasting conditions selected, or the coffee region of origin, or the coffee species. Similarly stated, the term “relevant acid” is defined herein as one of the taste contributing acids  
10 found within coffee that would be perceptible by taste at a concentration in water that is equal to the concentration of the acid in the target coffee and exhibits one or more of the following phenomenon: a coffee roasting effect, a coffee species effect, or a coffee region of origin effect.

15 It will further be appreciated by the ordinarily skilled artisan in view of the disclosure herein, that not all of the coffee acids that satisfy the heretofore mentioned conditions (i.e., perceptibility in water, roast effect, species effect, and region of origin effect) would necessarily be required to sufficiently mimic a given flavor profile. Factors including, but not limited to, cost, availability, ease of use, manufacturing complexity, classification as a food grade acid by an appropriate regulatory agency such as the U.S.  
20 Food and Drug Administration, and commercially significant consumer preference differences between subtly different profiles need to be considered when selecting the exact number and species of relevant acids to be used in the mimicking of a given flavor profile. Therefore, it may be suitable to use only a subset of the relevant acids (i.e., the relevant coffee components) identified within a given coffee to sufficiently mimic the  
25 characteristic flavor profile of that coffee.

As used herein, the term “principal acid” is defined as the relevant acid that experiences the largest change in its ratio between the total concentration of that acid in a first coffee (e.g., a coffee source) and the total concentration of the corresponding acid in a second coffee (e.g., a target coffee). By way of example, take a first coffee that contains  
30 three relevant acids, acid A, acid B, and acid C. The total concentrations of acids A, B, and C are 100 ppm, 150 ppm, and 200 ppm, respectively. Then take a second coffee

which also contains corresponding acids A, B, and C. The total concentrations of the corresponding acids in the second coffee are 200 ppm, 450 ppm, and 300 ppm, respectively. The ratios of each acid in the second coffee to the corresponding acid in the first coffee ( i.e., the total concentration of an acid in the second coffee divided by the 5 total concentration of the corresponding acid in the first coffee) are 2 (200 ppm/100 ppm), 3 (450 ppm/ 150 ppm), and 1.5 (300 ppm/200 ppm), respectively. Therefore, of the relevant acids, acid B is the principal acid because it experiences the largest change in the ratio of its total concentration.

The Applicants have found that the ability to accurately measure changes in the 10 concentration of a given acid within a coffee, analytically, is greater than the ability to measure a comparable change in concentration by the sensory perception of taste. The Applicants have also found that how closely the flavor profile of a first coffee needs to mimic the flavor profile of a second coffee (e.g. the total concentrations of relevant acids in a first coffee have substantially the same relative ratios to each to other as the 15 corresponding relevant acids in the second coffee) to provide a suitable, consumer acceptable approximation of that flavor profile is a function of the ability to accurately perceive the difference between the two profiles, more than the ability to analytically measure the difference.

In one embodiment of the present invention Applicants have determined that for a 20 characteristic flavor profile of a first set of relevant acids, such as would be found in an adjusted coffee (i.e., a coffee source that has been supplemented to mimic a target coffee), to be substantially similar to a characteristic flavor profile of a second set of relevant acids, such as would be found in a second or target coffee, so as to mimic the characteristic flavor profile of that second or target coffee the total concentration of the 25 principal acid of the adjusted coffee must be within in the range of about 50% below to about 50% above the total concentration of the corresponding acid in the target coffee. The total concentration for the principal acid in the adjusted coffee is within the range of from about 40% below to about 40% above the total concentration of the corresponding acid in the target coffee is preferred, a total concentration in the range of about 30% 30 below to about 30% above is more preferred, a total concentration in range of from about 20% below to about 20% above is yet more preferred, a total concentration in range of

from about 10% below to about 10% above is yet more preferred, and a total concentration in range of from about 5% below to about 5% above is most preferred.

Moreover, the value of the total concentration of the principal acid of the adjusted coffee divided by the total concentration of each of the relevant acids of the adjusted coffee is within the range of from about 50% below to about 50% above the value of the total concentration of the corresponding principal acid in the target coffee divided by the total concentration of each of the corresponding relevant acids in the target coffee. In other words, for a given adjusted coffee that has N relevant acids, the value of the total concentration of the principal acid (i.e. the principal coffee component) of the adjusted coffee divided by the total concentration of each of the N relevant acids (i.e., the relevant coffee component) of the adjusted coffee is within the range of from about 50% below to about 50% above the value of the total concentration of the corresponding principal acid in the target coffee divided by the total concentration of each of the corresponding N relevant acids in the target coffee. A value in the range of from about 40% below to about 40% above is preferred, a value in the range of from about 30% below to about 30% above is more preferred, a value in the range of from about 20% below to about 20% above is yet more preferred, a value in the range of from about 10% below to about 10% above is yet more preferred, and a value in the range of from about 5% below to about 5% above is most preferred.

The acceptable variation between the relative ratios of relevant acids in a first coffee (e.g., an adjusted coffee) and the relative ratios of the corresponding relevant acids in a second coffee (e.g., a target coffee) is a function of the particular coffees selected and the ability to perceive a particular acid by the sensory perception of taste. So, in order for the characteristic flavor profile of the first coffee to mimic the characteristic flavor profile of the second coffee, the pH of first coffee must be adjusted in such a way that the perceivable concentrations of relevant acids in the first coffee have substantially the same relative ratios to each other as the perceivable concentrations of corresponding relevant acids in the second coffee. When the pH of the first or adjusted coffee is within the range of about 2 units above to about 2 units below the pH of the second coffee (i.e., the target coffee), preferably in the range of from about 1 unit above to about 1 unit below, more preferably in the range of from about 0.5 units above to about 0.5 units below, most

preferably in the range of from about 0.2 units above to about 0.2 units below, the two coffees will have sufficiently similar perceivable concentrations of the relevant acids such that the characteristic flavor profile of the first or adjusted coffee will sufficiently mimic the targeted characteristic flavor profile of the second coffee.

5 As the perceptible concentration of a given relevant acid is a function of that acid's pKa value and the overall pH value of the solution, addition of a sufficient amount of one or more coffee source component modifiers will adjust the perceptible concentration of the relevant acid through adjustment of the overall pH value. These conditions can be expressed as follows:

10

- i)  $(.5)(P_{Second\ Coffee}) \leq (P_{First\ Coffee}) \leq (1.5)(P_{Second\ Coffee})$ ;
- ii)  $(.5)[(P_{Second\ Coffee}) / (R_{Second\ Coffee\ (n)})] \leq [(P_{First\ Coffee}) / (R_{First\ Coffee\ (n)})] \leq (1.5)[(P_{Second\ Coffee}) / (R_{Second\ Coffee\ (n)})]$ , for each of  $n$  relevant acids;
- 15 iii)  $pH_{First\ Coffee} = pH_{Second\ Coffee} \pm 2$  units

15

where  $P_{First\ Coffee}$  is the total concentration of the principal acid in the first coffee,  $P_{Second\ Coffee}$  is the total concentration of the corresponding principal acid in the second coffee,  $R_{First\ Coffee\ (n)}$  is the total concentration of the  $n^{th}$  relevant acid in the first coffee,  $R_{Second\ Coffee\ (n)}$  is the total concentration of the corresponding  $n^{th}$  relevant acid in the second coffee,  $pH_{First\ Coffee}$  is the pH value of the first coffee, and  $pH_{Second\ Coffee}$  is the pH value of the second coffee.

25

Applicants have further found that as it is the relative ratios of the relevant acids to each other that defines the characteristic flavor profile for that given set of acids, the absolute magnitude of the difference between the total concentrations of relevant acids between a first coffee and a second coffee is less critical in determining if the characteristic flavor profile of the first coffee is sufficiently similar to that of a second coffee so as to mimic that coffee's flavor profile. So, in another embodiment of the present invention, Applicants have determined that for a characteristic flavor profile of a first set of relevant acids, such as would be found in an adjusted coffee (i.e., a coffee source that has been supplemented to mimic a target coffee), to be substantially similar to

a characteristic flavor profile of a second set of relevant acids, such as would be found in a second or target coffee, so as to mimic that characteristic flavor profile of that second or target coffee, the total concentration of those relevant acids may be increased by as much as a factor of seven (7) (i.e., a magnitude adjustment factor of between 1-7), as long as the 5 relative ratios of the total concentration of the principal acid of the adjusted coffee is within in the range of about 50% below to about 50% above the total concentration of the corresponding acid in the target coffee, adjusted by the total magnitude adjustment factor. A total concentration for the principal acid in the adjusted coffee within the range of from about 40% below to about 40% above the total concentration of the corresponding acid in 10 the target coffee, adjusted by the total magnitude adjustment factor, is preferred, a total concentration in the range of about 30% below to about 30% above, adjusted by the total magnitude adjustment factor, is more preferred, a total concentration in range of from about 20% below to about 20% above, adjusted by the total magnitude adjustment factor, is yet more preferred, a total concentration in range of from about 10% below to about 15 10% above, adjusted by the total magnitude adjustment factor, is yet more preferred, and a total concentration in range of from about 5% below to about 5% above, adjusted by the total magnitude adjustment factor, is most preferred.

Additionally, the value of the total concentration of the principal acid of the adjusted coffee divided by the total concentration of each of the relevant acids of the 20 adjusted coffee should still be within the range of from about 50% below to about 50% above the value of the total concentration of the corresponding principal acid in the target coffee divided by the total concentration of each of the corresponding relevant acids in the target coffee. In other words, for a given adjusted coffee that has N relevant acids, the value of the total concentration of the principal acid (i.e. the principal coffee component) 25 of the adjusted coffee divided by the total concentration of each of the N relevant acids (i.e., the relevant coffee component) of the adjusted coffee is within the range of from about 50% below to about 50% above the value of the total concentration of the corresponding principal acid in the target coffee divided by the total concentration of each of the corresponding N relevant acids in the target coffee. A value in the range of from about 30 30 40% below to about 40% above is preferred, a value in the range of from about 30% below to about 30% above is more preferred, a value in the range of from about 20%

below to about 20% above is yet more preferred, a value in the range of from about 10% below to about 10% above is yet more preferred, and a value in the range of from about 5% below to about 5% above is most preferred.

Finally, in order for the characteristic flavor profile of the first coffee to mimic the characteristic flavor profile of the second coffee, the pH of first coffee must be adjusted in such a way that the perceivable concentrations of relevant acids in the first coffee have substantially the same relative ratios to each other as the perceivable concentrations of corresponding relevant acids in the second coffee. When the pH of the first or adjusted coffee is within the range of about 2 units above to about 2 units below the pH of the second coffee (i.e., the target coffee), preferably in the range of from about 1 unit above to about 1 unit below, more preferably in the range of from about 0.5 units above to about 0.5 units below, most preferably in the range of from about 0.2 units above to about 0.2 units below, the two coffees will have sufficiently similar perceivable concentrations of the relevant acids such that the characteristic flavor profile of the first or adjusted coffee will sufficiently mimic the targeted characteristic flavor profile of the second coffee. As the perceptible concentration of a given relevant acid is a function of that acid's pKa value and the overall pH value of the solution, addition of a sufficient amount of one or more coffee source component modifiers will adjust the perceptible concentration of the relevant acid through adjustment of the overall pH value.

These conditions can be expressed as follows:

- i)  $(M) (0.5) (P_{Second\ Coffee}) \leq (P_{First\ Coffee}) \leq (M) (1.5) (P_{Second\ Coffee})$ ;
- ii)  $(.5) [(P_{Second\ Coffee}) / (R_{Second\ Coffee\ (n)})] \leq [(P_{First\ Coffee}) / (R_{First\ Coffee\ (n)})] \leq (1.5) [(P_{Second\ Coffee}) / (R_{Second\ Coffee\ (n)})]$ , for each of  $n$  relevant acids;
- iii)  $pH_{First\ Coffee} = pH_{Second\ Coffee} \pm 2\ units$

where  $M$  is the magnitude adjustment factor and has a value in the range of from about 1 to about 7,  $P_{First\ Coffee}$  is the total concentration of the principal acid in the first coffee,  $P_{Second\ Coffee}$  is the total concentration of the corresponding principal acid in the second coffee,  $R_{First\ Coffee\ (n)}$  is the total concentration of the  $n^{\text{th}}$  relevant acid in the first coffee,  $R_{Second\ Coffee\ (n)}$  is the total concentration of the corresponding  $n^{\text{th}}$  relevant acid in the

second coffee,  $\text{pH}_{\text{First Coffee}}$  is the pH value of the first coffee, and  $\text{pH}_{\text{Second Coffee}}$  is the pH value of the second coffee.

In one particularly preferred embodiment of the present invention the total concentration of the principal acid of the adjusted coffee is within in the range of about 50% below to about 50% above the total concentration of the corresponding acid in the target coffee, adjusted by the total magnitude adjustment factor; the value of the total concentration of the principal acid of the adjusted coffee divided by the total concentration of each of the relevant acids of the adjusted coffee is within the range of from about 50% below to about 50% above the value of the total concentration of the corresponding principal acid in the target coffee divided by the total concentration of each of the corresponding relevant acids in the target coffee; the pH of the first or adjusted coffee is within the range of about 2 units above to about 2 units below the pH of the second coffee (i.e., the target coffee); and, the value of the total concentration of the principal acid of the adjusted coffee divided by the total concentration of each of the relevant acids of the adjusted coffee is equal to the value of the total concentration of the principal acid of the target coffee divided by the total concentration of each of corresponding relevant acids in the target coffee. The last condition can be restated as the relative ratios of the principal and other relevant acids in the adjusted coffee to each other is equal to the relative ratios of the principal and other relevant acids in the target coffee to each other.

The conditions for this embodiment of the present invention can be expressed as follows:

- i)  $(M)(.5)(P_{\text{Second Coffee}}) \leq (P_{\text{First Coffee}}) \leq (M)(1.5)(P_{\text{Second Coffee}});$
- 25 ii)  $(.5)[(P_{\text{Second Coffee}}) / (R_{\text{Second Coffee (n)}})] \leq [(P_{\text{First Coffee}}) / (R_{\text{First Coffee (n)}})] \leq (1.5)[(P_{\text{Second Coffee}}) / (R_{\text{Second Coffee (n)}})],$  for each of  $n$  relevant acids;
- iii)  $\text{pH}_{\text{First Coffee}} = \text{pH}_{\text{Second Coffee}} \pm 2 \text{ units};$
- 30 iv)  $[(P_{\text{First Coffee}}) / (R_{\text{First Coffee (n)}})] = [(P_{\text{Second Coffee}}) / (R_{\text{Second Coffee (n)}})]$  or alternatively as,  
 $[P_{\text{First Coffee}}] : [R_{\text{First Coffee (1)}}] : \dots : [R_{\text{First Coffee (n)}}] = [P_{\text{Second Coffee}}] : [R_{\text{Second Coffee (1)}}] : \dots : [R_{\text{Second Coffee (n)}}].$

where  $M$  is the magnitude adjustment factor and has a value in the range of from about 1 to about 7,  $P_{First\ Coffee}$  is the total concentration of the principal acid in the first coffee,  $P_{Second\ Coffee}$  is the total concentration of the corresponding principal acid in the second coffee,  $R_{First\ Coffee\ (n)}$  is the total concentration of the  $n^{th}$  relevant acid in the first coffee, 5  $R_{Second\ Coffee\ (n)}$  is the total concentration of the corresponding  $n^{th}$  relevant acid in the second coffee,  $pH_{First\ Coffee}$  is the pH value of the first coffee, and  $pH_{Second\ Coffee}$  is the pH value of the second coffee.

## K. Preparation of Flavored Coffee Beverages and Compositions

10 Figure 4 is a flow diagram of the process steps of one embodiment of the present invention of the present invention. Referring to the Figure 4, step 402 is selecting a target coffee beverage comprising a target coffee element. The target coffee element can be in a variety of forms such as cherries, beans, leaves, and bark. Additionally, the coffee element can take the form of soluble coffee, roast and ground, roasted whole bean, green 15 coffee, and extracts of coffee via aqueous, super-critical fluid, and organic solvent extraction processes. The coffee element can also be caffeinated, decaffeinated, or a blend of both.

20 The target coffee beverage may optionally contain additional elements, such as foaming agents, mouthfeel enhancing agents, flavorants, creamy components, inert fillers and carriers, sweetening agents, and the like.

Step 404 is acquiring the target coffee component profile showing the concentration of the relevant target coffee components. Step 406 is determining the pH value of the coffee element of the target coffee. The pH value is measured at standard temperature and pressure. One skilled in the art will appreciate that though the target 25 coffee element of the target coffee beverage might have a given pH value, the pH value of the target coffee beverage as a whole might be different, depending on the presence of additional elements.

Step 408 is selecting a suitable coffee source. The coffee source can be in a variety of forms such as cherries, beans, leaves, and bark. Additionally, the coffee source 30 can take the form of soluble coffee, roast and ground, roasted whole bean, green coffee, and extracts of coffee via aqueous, super-critical fluid, and organic solvent extraction

processes. The coffee source can also be caffeinated, decaffeinated, or a blend of both. Step 410 is acquiring the coffee source component profile showing the concentration of the relevant coffee source components. Step 412 is to determine the pH value of the coffee source. The pH value is measured at standard temperature and pressure.

5        Step 414 is selecting the appropriate supplemental coffee source component or components corresponding to one or more relevant coffee source components and target coffee components and the amount required, if any, to appropriately modify the coffee source component profile. The quantity of supplemental coffee source component required is determined by the difference between the total concentration of the coffee

10      source component and the target coffee component. The amount required is also determined by the amount of supplemental coffee source components required, if any, such that the resulting coffee component profile of relevant resulting coffee source components will be substantially similar to the target coffee component profile of corresponding acids, so that the resulting coffee component will sufficiently mimic the

15      characteristic flavor of the target coffee element. If the total concentration of the coffee source component is less than the total concentration of the target coffee component, a sufficient amount of a supplemental coffee source component is added so that the total concentration of the resulting coffee source component is within the acceptable range of the total concentration of the target coffee component. If the total concentration of the

20      coffee source component is in excess of the total concentration of the target coffee component, then the addition of a supplemental coffee source component is not necessarily required. However, if the concentration of all relevant coffee components is to be increased by some magnification adjustment factor the use of a supplemental coffee source component may be required.

25      Step 416 is selecting the appropriate coffee source component modifier, and the amount required to sufficiently adjust the perceptible concentration of the resulting coffee source component so that it is within the acceptable range of the pH value of the corresponding target coffee component. This will allow the characteristic flavor profile of the resulting coffee portion to suitably mimic the characteristic flavor profile of the target

30      coffee element. The amount of coffee source component modifier required depends, in part, on the coffee source and the coffee element of the target coffee selected.

Step 418 is formulating the resulting coffee portion by combining the selected supplemental coffee source components and the coffee source component modifier, if required, with the coffee source. As described above, the supplemental coffee source component and coffee source component modifier can exist and be applied in a variety of forms. Moreover, the application of the supplemental coffee source components and coffee source component modifier does not have to occur at the same moment. Additionally, the components can be applied at any point in the preparation of the coffee beverages or compositions of the present invention. They may also be combined with the coffee source, either together or individually, during the formation of any intermediate product used in the creation of the coffee beverages or compositions of the present invention.

Depending on the coffee source selected, the supplemental coffee source components and the coffee source component modifier, if required, can be delivered to the coffee beverages or compositions of the present invention: by a machine or other dispensing apparatus; by impregnating the ingredients in the lining of a cup; by impregnating the ingredients in a filter; by pre-measured tablet or packet; and, through the water used in various stages of product preparation (e.g., the roasting quench used to cool a post-roasted coffee, or the water used to create the final, consumable coffee beverage). The components and modifiers may also be introduced via spraying, coating, soaking, co-mixing, or other suitable method.

If the coffee source is an agglomerated instant coffee product, for example, the components and modifiers of the present invention could be combined with the coffee source via part of an agglomeration binding solution (e.g., carbohydrate and/or starch, water, or other suitable surfactant); in a dry form that be part of the agglomeration; sprayed onto the agglomerated particle in liquid form; or, coated to an otherwise physically inert ingredient (e.g., sucrose, maltodextrin).

It will be appreciated by one skilled in the art upon reading the disclosure herein that one or more of the following steps may be omitted entirely or possibly performed on a periodic basis, possibly as part of a quality control program. Depending on the accuracy of the analytical data obtained on the various component profiles and the exact amount of supplemental coffee source component(s) and/or coffee source component modifier(s)

added, the resulting coffee component profile and/or the pH value of the resulting coffee portion of the finished beverage can be calculated with sufficient accuracy to practice the present invention.

Step 420 is acquiring the resulting coffee component profile showing the total concentration of the resulting coffee source components. Step 422 is determining the pH value of the coffee portion of the resulting coffee beverage. The pH value is measured at standard temperature and pressure. Steps 424 and 426 require validating the results by comparing the resulting coffee component profile with the target coffee component profile and ensuring that the coffee portion is within an acceptable pH range of the coffee element of the target coffee.

One skilled in the art will appreciate that each and every step of the method described above is not required for every execution of the present invention. The exact sequence and number of steps required is also dependent on the particular execution of the present invention employed.

15

## **L. EXAMPLES**

The following examples further describe and demonstrate embodiments within the scope of the present invention. These examples are given solely for the purpose of illustration and are not to be construed as a limitation of the present invention, as many variations thereof are possible without departing from the invention's spirit and scope.

### **1. METHOD FOR DETERMINATION OF COFFEE COMPONENTS**

The coffee components of the present invention are separated and quantified by Ion Chromatography (IC) utilizing alkaline anion-exchange with conductivity detection. The system is a Dionex DX 500 Ion Chromatograph comprising:

- i) IP25 Isocratic Pump;
- ii) EG-40 Eluent Generator;
- iii) Ion Pac ATC-1 anion-trap PN#37151;
- iv) AS50 Autosampler;
- 30 v) LC30 Chromatography Oven;
- vi) Ion Pac AS-11HC column (4mm x 20cm) (PN 052960);

vii) Ion Pac AG-11-HC (PN 052962) guard column;

viii) CD20 Conductivity Detector; and,

ix) 4mm ASRS-Ultra suppressor.

5 The chromatographic column consists of a 9- $\mu$ m highly cross-linked macroporous ethylvinylbenzene-divinylbenzene resin core with 70-nm diameter microbeads of anion-exchange latex attached to the surface. The mobile phase is electrolytically generated from distilled-deionized water by using a Dionex EG-40 Eluent Generator and is characterized as follows:

10 1. Eluent A: 18 Mohm-cm Milli-Q water or better, filtered through a 0.45mm filter, degassed, and transferred to reservoir A with a continuous blanket of nitrogen.

2. Eluent B: Potassium Hydroxide Cartridge (EluGen EGC-KOH EluGen cartridge, Dionex Inc.)

Deionized water is delivered by the pump to the EluGen Cartridge in the EG40. DC

15 current is applied to the EluGen Cartridge to produce potassium hydroxide eluent. The resulting mobile phase gradient is described in Table 2 below.

| <u>time (min)</u> | <u>[NaOH] (mM)</u> | <u>Ramp</u> |
|-------------------|--------------------|-------------|
| 0                 | 1                  |             |
| 15                | 1                  | isochratic  |
| 25                | 15                 | linear      |
| 35                | 30                 | linear      |
| 60                | 60                 | linear      |

**Table 2**

20 The column is kept at a temperature of 32°C. The flow rate is 1.5 mL/min and the injection volume is 10  $\mu$ L. The data collection time is 55 minutes at a data collection rate of 5 points per second.

25 The above described analytical method is further disclosed in Dionex Corporation Application Note 123, "Determination of Inorganic Anions and Organic Acids in Fermentation Broths" and, Dionex Corporation Application Note 25, "Determination of

Inorganic Anions and Organic Acids in Non-Alcoholic Carbonated Beverages", herein incorporated by reference.

The first step in the method for the identification, separation, and quantification of coffee components is to prepare an aqueous sample solution of the substance to be analyzed

5 (coffee source, target coffee, or coffee portion). The aqueous sample solution must then be filtered to remove large suspended solids. A purified sample is then collected and analyzed using the above equipment.

By way of example, if the substance to be analyzed is roasted and ground coffee then first weigh 2.0 grams of R&G into a 100ml volumetric flask. Add 50ml of boiling HPLC

10 water to the sample and boil on a hot plate for 10 minutes. Cool to room temperature and bring to volume with HPLC water. Then filter 2ml through a 0.45mm Nylon Membrane filter (acrodisc). Discard the first 1ml and collect the second 1ml in a sample vial and cap. Finally, analyze the purified sample using the above described equipment.

If the substance to be analyzed is a brewed coffee then filter approximately 2ml through a

15 0.45mm Nylon Membrane filter (acrodisc). Discard the first 1ml and collect the second 1ml in a sample vial and cap. Finally, analyze the purified sample using the above described equipment.

If the substance to be analyzed is a soluble coffee then weigh 1 gram of the soluble coffee into a 100ml volumetric flask. Add 50ml of boiling HPLC water to the sample. Swirl the

20 solution to mix well, then cool and dilute to volume. Then filter 2ml through a 0.45mm Nylon Membrane filter (acrodisc). Discard the first 1ml and collect the second 1ml in a sample vial and cap. Finally, analyze the purified sample using the above described equipment.

If the substance to be analyzed is a coffee extract then it will need to be diluted in  
25 order to pass through the 0.45mm Nylon Membrane filter (acrodisc). The extent of the dilution is dependent upon the viscosity of the particular sample to be analyzed. If the sample to be analyzed is in a form other than described above it will need to be prepared as outlined above. Samples that will not be analyzed shortly following preparation require refrigeration.

## Calibration of the Ion Chromatography Method

One skilled in the art will appreciate that calibration is necessary to convert detector response to measures of concentration (e.g., parts per million, milligrams per liter, and the like). Calibration of the IC method is performed by preparing solutions of the free acids

5 (when available as solids of sufficient purity) or of the sodium or potassium salts.

Response factors (RF, ppm/peak area) were determined by a five level calibration for quinic, lactic, acetic, formic, malic, phosphoric and citric acids. Where the salts were used, gravimetric factors were applied such that the RF values corresponded to free acid concentration (ppm).

## 10 Quinic Acid

Quinic acid (Aldrich 77-95-2, 98% pure, FW = 192.17 g/mol) was used. A primary stock solution was prepared by weighing 0.1015 g into a 100 mL volumetric flask. A secondary stock was prepared by 10-fold dilution. Five calibration solutions were made by successive 2-fold dilutions of the secondary stock. The fit was linear ( $r^2=0.9998$ ) over a 6 to 100 ppm range.

## Lactic Acid

Sodium lactate (Sigma L-7022, approx. 98% pure, FW = 112.06 g/mol) was dried overnight in a desiccator containing  $\text{CaSO}_4$ . A primary stock solution was prepared by weighing 0.1079 g into a 100 mL volumetric flask. A secondary stock was prepared by 10-fold dilution. Five calibration solutions were made by successive 2-fold dilutions of the secondary stock. The fit was linear ( $r^2=0.9996$ ) over a 5 to 85 ppm range.

## Acetic Acid

Sodium acetate (Sigma S7545, 99.0% pure, FW = 82.03 g/mol) was used. A primary stock solution was prepared by weighing 0.1035 g into a 100 mL volumetric flask. A secondary stock was prepared by 10-fold dilution. Five calibration solutions were made by successive 2-fold dilutions of the secondary stock. A quadratic fit ( $r^2=0.9999$ ) was preferred to a linear fit ( $r^2=0.984$ ) over the 5 to 75 ppm range.

## Formic Acid

Sodium formate (Sigma S2140, 99.6% pure, FW = 68.01 g/mol) was used. A primary stock solution was prepared by weighing 0.1007 g into a 100 mL volumetric flask. A secondary stock was prepared by 10-fold dilution. Five calibration solutions were made

by successive 2-fold dilutions of the secondary stock. The fit was linear ( $r^2=0.9990$ ) over a 4 to 70 ppm range.

### **Malic Acid**

Malic acid (Aldrich 617-48-1, 99+% pure, FW = 134.09 g/mol) was used. A primary

5 stock solution was prepared by weighing 0.1020 g into a 100 mL volumetric flask. A secondary stock was prepared by 10-fold dilution. Five calibration solutions were made by successive 2-fold dilutions of the secondary stock. A quadratic fit ( $r^2=0.9999$ ) was preferred to a linear fit ( $r^2=0.985$ ) over the 6 to 100 ppm range.

### **Phosphoric Acid**

10 Potassium phosphate, monobasic (Aldrich 7778-77-0, 99% pure, FW = 136.09 g/mol) was used. A primary stock solution was prepared by weighing 0.1020 g into a 100 mL volumetric flask. A secondary stock was prepared by 10-fold dilution. Five calibration solutions were made by successive 2-fold dilutions of the secondary stock. Fit was linear ( $r^2=0.9999$ ) over a 5 to 75 ppm range.

### **Citric Acid**

Citric acid (Aldrich 77-92-9, 99+% pure, FW = 192.12 g/mol) was used. A primary stock solution was prepared by weighing 0.1034 g into a 100 mL volumetric flask. A secondary stock was prepared by 10-fold dilution. Five calibration solutions were made by successive 2-fold dilutions of the secondary stock. A quadratic fit ( $r^2=0.9999$ ) was

20 preferred to a linear fit ( $r^2=0.989$ ) over the 6 to 100 ppm range.

## **EXAMPLES**

### **Example 1**

25 In one embodiment of the present invention a target coffee comprising a coffee element is identified (Colombian coffee roasted roaster for 180 seconds, using a Thermalo model roaster, to a Hunter color of 18.0L). The target coffee is prepared from roast and ground coffee. The roasted coffee is ground using a Grindmaster Model 875 burr grinder on an ADC setting. A brew is prepared using 33.3g of the roast and ground

30 coffee per 1420 mLs of distilled water in a Mr. Coffee type coffee brewer. This produces

an aqueous solution of the target coffee source that has a total solids content of about .5-1.0% by weight. A solids content in the range of from about .5-.65 is preferred.

A filtered 2ml aliquot of the aqueous solution of the target coffee is then analyzed for total ion concentration of target coffee components. This done using a Dionex 500 HPLC system and the analytical method for determining ion concentration described above. A target coffee component profile is identified in PPM.

A coffee source is identified and processed (Honduran coffee that has been roasted using a Thermalo model roaster for 3 minutes, to a Hunter LAB color of 18.0L). The coffee source is then ground using a Grindmaster Model 875 burr grinder on an ADC setting. A brew is prepared using 33.3g of the coffee source per 1420 ml of distilled water in a Mr. Coffee type coffee brewer. This produces an aqueous solution of the coffee source that has a total solids content of about .5-1.0% by weight. A solids content in the range of from about .5-.65 is preferred.

A filtered 2ml aliquot of the aqueous solution of the coffee source is then analyzed for total ion concentration of coffee source components using a Dionex 500 HPLC system and the analytical method for determining ion concentration described above. A coffee source component profile is identified in PPM.

The quantity of the supplemental coffee source component to be added is calculated as the difference between the total ion concentration of the target coffee component and the coffee source component, as is demonstrated in **Table 3**.

|                         | Lactate | Acetate | Formate | Malate | Phosphate | Citrate |
|-------------------------|---------|---------|---------|--------|-----------|---------|
| Target Coffee Component | 33.4    | 186.5   | 62.9    | 65.0   | 36.9      | 194.3   |
| Coffee Source Component | 26      | 185.5   | 64.9    | 79.0   | 35.5      | 200.4   |
| Difference              | 7.4     | 1.1     | N/A     | N/A    | 1.4       | N/A     |

**Table 3**

A quantity of a supplemental source component, in an amount that is equal to or greater than the amount of the difference between the target coffee component and the

coffee source component, is combined with the coffee source. The supplemental coffee source component is added in its acidic form. However, the supplemental coffee source component may also be added as the  $\text{Na}^+$  or  $\text{K}^+$  salt of the acid.

5 The pH value of the coffee element of the target coffee is measured at standard temperature and pressure. The pH value of the coffee portion is then measured and adjusted with a sufficient amount of a coffee source component modifier (NaOH) to be within +/- 0.1 units of the pH of the coffee element of the target coffee.

10 A filtered 2ml aliquot of the coffee portion is then analyzed for total ion concentration using the analytical method for determining ion concentrations described above. A resulting coffee component profile is then identified in PPM and compared with target coffee component profile. The results are exhibited in **Table 4**.

|                                    | Lactate | Acetate | Formate | Malate | Phosphate | Citrate |
|------------------------------------|---------|---------|---------|--------|-----------|---------|
| Target Coffee Component Profile    | 33.4    | 186.5   | 62.9    | 65.0   | 36.9      | 194.3   |
| Resulting Coffee Component Profile | 33.4    | 186.5   | N/A     | N/A    | 36.9      | N/A     |

**Table 4**

15 **Example 2**

In another embodiment of the present invention a target coffee composition comprising a coffee element is identified. The coffee element of the target coffee is a blend containing 65% arabica coffee roasted for 3 minutes to a Hunter color of 17.9L, and 35% robusta coffee roasted for 3 minutes to a Hunter color of 25.5L using a Thermal 20 model coffee roaster. The two coffees of the coffee element are blended using a Forberg model fluid bed mixer and ground using a Grindmaster Model 875 burr grinder set to the ADC setting. A brew is prepared using a Mr. Coffee type coffee brewer. A Mr. Coffee filter is filled with 33.3g of the coffee element and the water reservoir is filled with 1420

mLs of distilled water. The brewer is then turned on to automatically brew the coffee. A filtered 2ml aliquot of the aqueous solution (0.45mm filter Nylon Membrane filter) is analyzed for total ion concentration. A target coffee component profile is identified in PPM.

5 A coffee source is identified and processed (a blend containing 70% robusta coffee roasted for 3 minutes to a Hunter color of 21.5L, and 30% arabica coffee roasted for 3 minutes to a color of 17.9L using a Thermalo model coffee roaster). The coffee source is blended using a Forberg model fluid bed mixer and ground using a Grindmaster Model 875 burr grinder set to the ADC setting. A brew is prepared using a Mr. Coffee 10 type coffee brewer. A Mr. Coffee filter is filled with 33.3g of the coffee and the water reservoir is filled using 1420 mL of distilled water. The brewer is then turned on to automatically brew the coffee. A filtered 2ml aliquot of the aqueous solution (0.45mm filter Nylon Membrane filter) is analyzed for total ion concentration. A coffee component profile is identified in PPM.

15 The quantity of the supplemental coffee source component to be added is calculated as the difference between the total ion concentration of the target coffee component and the coffee source component, as is demonstrated in **Table 5**.

|                                 | Lactate | Acetate | Formate | Malate | Phosphate | Citrate |
|---------------------------------|---------|---------|---------|--------|-----------|---------|
| Target Coffee Component Profile | 22.9    | 178.6   | 55.7    | 64.0   | 42.2      | 173.6   |
| Coffee Source Component Profile | 22.0    | 178.6   | 53.9    | 56.5   | 47.5      | 160.0   |
| Difference                      | .9      | 0       | 1.8     | 7.5    | N/A       | 13.6    |

Table 5

20 The supplemental coffee source component is added by preparing a solution made from 0.0643g of an 85% solution of Lactic Acid, 0.1013g of a 99 % solution of Formic Acid, 0.7919g of granular Malic Acid and 1.2795g of granular Citric Acid. The acids are combined in a 100ml volumetric flask, and distilled/deionized water is added to bring the volume to 100ml. 1 ml of this solution is equal to the addition of .9PPM of Lactic Acid, 25 1.8 PPM of Acetic Acid, 7.5PPM of Malic Acid and 9.4PPM of Citric Acid per 1320 mL

of brewed selected second coffee source having been brewed using a Mr. Coffee type coffee maker and a Mr. Coffee filter with 33.3g of coffee and 1420 mL of distilled water. To 1320 mL of the brewed coffee source 1 ml of the acid mixture containing of .9PPM of Lactic Acid, 1.8 PPM of Acetic Acid, 7.5PPM of Malic Acid and 13.6 PPM of Citric

5 Acid was added.

The pH value of the coffee element of the target coffee is measured at standard temperature and pressure. The pH value of the coffee portion is then measured and adjusted with a sufficient amount of a coffee source component modifier (NaOH) to be within +/- 0.5 units of the pH of the coffee element of the target coffee. This is 10 accomplished by adding .6 mL of 1 M NaOH to 1320 mL of the brewed coffee source.

A filtered 2ml aliquot of the coffee portion is then analyzed for total ion concentration using the analytical method for determining ion concentrations described above. A resulting coffee component profile is then identified in PPM and compared with target coffee component profile. The results are exhibited in **Table 6**.

15

|                                       | Lactate | Acetate | Formate | Malate | Phosphate | Citrate |
|---------------------------------------|---------|---------|---------|--------|-----------|---------|
| First<br>Coffee<br>Source             | 22.9    | 178.6   | 55.7    | 64.0   | 42.2      | 173.6   |
| Treated<br>Second<br>Coffee<br>Source | 22.9    | 178.6   | 55.7    | 64.0   | N/A       | 173.6   |

Table 6

### Example 3

In another embodiment of the present invention a target coffee composition 20 comprising a coffee element is identified. The coffee element of the target coffee is a Colombian instant coffee that has been freeze concentrated, spray dried, and 10g of the coffee element is hydrated using 990 mL of water. This produces an aqueous solution with a total solids content of about 1.0% by weight. A solids content in the range of from

about .5-.1.65 is preferred. A filtered 2ml aliquot of the aqueous solution of the target coffee is analyzed for total ion concentration of target coffee components. A target coffee component profile is identified in PPM.

A coffee source is identified and processed (spray dried Brazilian instant coffee).

5 10g of the coffee element is hydrated using 990 mL of water. This produces an aqueous solution with a total solids content of about 1.0% by weight. A filtered 2ml aliquot of the aqueous solution of the coffee source is then analyzed for total ion concentration. A coffee source component profile is identified in PPM.

The quantity of the supplemental coffee source component to be added is

10 calculated as the difference between the total ion concentration of the target coffee component and the coffee source component, as is demonstrated in **Table 7**.

|                                 | Lactate | Acetate | Formate | Malate | Phosphate | Citrate |
|---------------------------------|---------|---------|---------|--------|-----------|---------|
| Target Coffee Component Profile | 35.5    | 149.1   | 48.0    | 61.3   | 105.2     | 147.4   |
| Coffee Source Component Profile | 54.5    | 87.5    | 47.7    | 28.7   | 88.1      | 115.2   |
| Difference                      | N/A     | 61.7    | 0.3     | 32.6   | 17.1      | 32.2    |

**Table 7**

A quantity of a supplemental source component, in an amount that is

15 equal to or greater than the amount of the difference between the target coffee component and the coffee source component, is combined with the coffee source. The supplemental coffee source component is added in its acidic form. However, the supplemental coffee source component may also be added as the  $\text{Na}^+$  or  $\text{K}^+$  salt of the acid.

The pH value of the coffee element of the target coffee is measured at standard

20 temperature and pressure. The pH value of the coffee portion is then measured and adjusted with a sufficient amount of a coffee source component modifier (NaOH) to be within +/- 0.1 units of the pH of the coffee element of the target coffee.

A filtered 2ml aliquot of the coffee portion is then analyzed for total ion concentration using the analytical method for determining ion concentrations described

25 above. A resulting coffee component profile is then identified in PPM and compared with target coffee component profile. The results are exhibited in **Table 8**.

|  | Lactate | Acetate | Formate | Malate | Phosphate | Citrate |
|--|---------|---------|---------|--------|-----------|---------|
| Target<br>Coffee<br>Component<br>Profile | 35.5    | 149.1   | 48.0    | 61.3   | 105.2     | 147.4   |
| Coffee<br>Source<br>Component<br>Profile | N/A     | 149.1   | 48.0    | 61.3   | 105.2     | 147.4   |

**Table 8**

**Example 4**

5 In another embodiment of the present invention a target coffee comprising a coffee element is identified (100% Arabica roast and ground coffee sold under the trade name Folgers Ultra Roasted Commercial Coffee <sup>TM</sup>, sold by the Procter and Gamble Company of Cincinnati, OH. ). A target coffee component profile of the roast and ground coffee element is identified in PPM, using a Dionex 500 HPLC system and the analytical 10 method for determining ion concentration described above.

15 A roast and ground coffee source is identified and processed (100% Columbian coffee, roasted using a Thermal model roaster to a Hunter color of 20.0L). A coffee source component profile of the roast and ground coffee source is identified in PPM, using a Dionex 500 HPLC system and the analytical method for determining ion concentration described above.

16 The appropriate quantity of the supplemental coffee source component to combine with the coffee source is provided by adding 17 mL of the following 1.0 M acid blend: 0.7 PPM acetic acid; 6.8 PPM formic acid; 11.1 PPM Malic Acid; 0.8 PPM Fumaric Acid; and, 20.4 PPM Citric Acid. The appropriate quantity of the coffee source 20 component modifier to combine with the coffee source is provided by adding 10.2 mL of 1.0 M NaOH.

A sample the coffee portion is then analyzed for total ion concentration using the analytical method for determining ion concentrations described above. A resulting coffee component profile is then identified in PPM and compared with target coffee

component profile. The concentration of the resulting coffee component in a resulting coffee component profile is at least as much as the concentration of the target coffee component in the target coffee component profile.

Having now described several embodiments of the present invention it should be clear to those skilled in the art that the forgoing is illustrative only and not limiting, having been presented only by way of exemplification. Numerous other embodiments and modifications are contemplated as falling within the scope of the present invention as defined by the appended claims thereto.

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